SECOND EDITION.

TONNAGE..

AND

FREEBOARD

OF

MERCHANT SHIPS.

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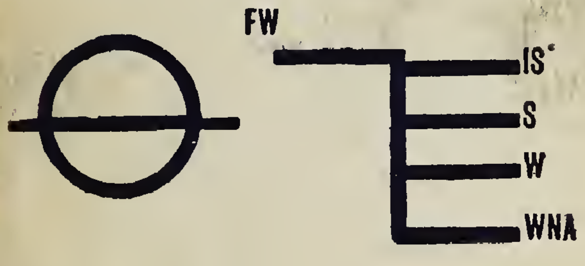

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The Tonnage and Freeboard
OF
Merchant Ships.

BY
H. OWEN, *A.I.N.A.*,
Author of "AIDS TO STABILITY," Etc.

SECOND EDITION.

GLASGOW:
PUBLISHED BY JAMES BROWN & SON,
The Nautical Press.

1907.

PREFACE.

WHATEVER truth there may be in the charge of ignorance brought against the shipping community (outside departmental precincts) relating to matters so vitally important to the economic success of a ship as Tonnage and Freeboard, there still remains the same love of information.

It is to the suggestion of brother officers seeking light and guidance upon these knotty subjects, that this publication is due, and if within its covers there should be noticed any of those familiar phrases or passages employed in official pamphlets, I can only give my assurance that the material has been obtained through careful study of the Merchant Shipping Act, with its many additions and expansions since its birth in 1854.

The purpose is *not* to introduce any novel exposition of the Tonnage and Freeboard Rules, but merely to render them in as simple and condensed a form as is consistent with clearness.

H. O.

SOUTHAMPTON, *April*, 1906.

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TONNAGE.

DEFINITION OF TONNAGE—SPACES EXEMPTED FROM MEASUREMENT FOR GROSS TONNAGE UNDER BRITISH, FRENCH, ITALIAN, AND SUEZ CANAL RULES—NET TONNAGE—DEDUCTIONS UNDER BRITISH, FRENCH, ITALIAN, AND SUEZ CANAL RULES—UNDER-DECK TONNAGE AND HOW TO OBTAIN IT—EXAMPLES—DEDUCTION ALLOWED FOR PROPELLING POWER UNDER BRITISH RULES—"ACTUAL ENGINE ROOM" SPACE—HOW TO FIND THE NET TONNAGE—LIGHT AND AIR SPACE AND HOW IT AFFECTS THE NET TONNAGE—RULE II. FOR MEASURING TONNAGE.

WE have no authentic record of the origin of the word tonnage, though it has been in use in connection with ships and imposts for centuries past.

In the early days of sail it conveyed a fairly good idea of the relative size and capacity of a ship, but the rapid advancement in the science of naval architecture since the introduction of steam has deprived the expression of its original signification, so that to-day it merely represents a kind of basis for levying dues and charges.

There are various expressions which we may employ when speaking of the size or capacity of a ship. Those in common use are: displacement, deadweight, and registered tonnage (gross or net).

Needless to say, these terms frequently lead to much confusion. To the *lay mind* "a ton is a ton" much in the same way as a "spade is a spade," and when told that a certain enterprising shipping firm has acquired a 10,000 tonner he does not pause to inquire whether these figures represent tons of displacement, deadweight, or registered tons. It would hardly occur to him that a ton of displacement or deadweight was only $\frac{7}{20}$ the volume of a registered ton.

For example, the ss. "A——" may be described as a vessel of

5346	Tons	Gross	100 cub. ft. to the ton.
2969	,,	Net	
9100	Tons	Load Displacement	35 cub. ft. to the ton.
4430	,,	Light ,,	
3520	,,	Deadweight	

The three registered tonnages, however, are the Gross, Net, and Under-deck; which, owing to the difficulty in establishing a comparative relation between them, will here be dealt with separately, always keeping in mind that a registered ton is estimated at 100 cubic feet or 2.83 cubic metres, and is quite distinct from a ton of displacement or deadweight, which is only 35 cubic feet or 0.99 cubic metre.

GROSS TONNAGE.

The International Tonnage Committee of 1873 unanimously agreed that Gross Tonnage should *comprise the exact measurement of all spaces* (*without any exception*) *below the upper-deck, as well as permanently covered and closed-in spaces on that deck.*

This definition, simple as it reads, nevertheless appears to be short of some feature necessary to its completeness, inasmuch as the *spaces* on the upper-deck exempted from measurement are not adequately described, and we have no definite understanding as to what really constitutes a *bona fide* exception. Meanwhile, each country applies the term to its most profitable use.

Under British Rules the following closed-in spaces above the upper-deck are reckoned as exceptions, and therefore do ***not*** form part of the Gross Tonnage :—

1. Volume of hatchways to the extent of ½ per cent. of the vessel's gross tonnage (anything in excess of this amount is included in the gross tonnage).
2. Poops, bridges, or other deck erections not provided with doors for their openings to the deck.
3. Wheel-house, condenser space, galley, bakery (when fitted with ovens), and W.C.'s* for the use of officers and crew, or any closed-in deck space having machinery within. Such spaces shall not be larger than required for the purpose.
4. Closed-in erections on the upper-deck (temporary or otherwise) provided for the sheltering of deck passengers during short sea voyages. Full particulars of erections, and claim for exemption must be submitted to the Board of Trade.
5. Light and air space above engine and boiler-room (but not below the upper-deck) may be added to gross tonnage at owner's option, upon giving notice to that effect to the Marine Department or the Board of Trade.
6. Ballast tanks and double bottoms exclusively used for carrying water ballast.

N.B.—Closed-in spaces ***not*** measured for ***gross tonnage*** will not be allowed to count as a deduction for ***net tonnage.*** For instance, closed-in spaces on the upper-deck occupied by helm and anchor gear are not included in either tonnage.

Under French Rules the entire volume of hatchways is measured for gross tonnage. In other respects the British measurement is accepted.

---

* A passenger ship is allowed an extra W.C. for every 50 passengers' accommodation space.

Under Italian Rules the volume of hatchways is totally disregarded, and therefore not included in the gross tonnage measurement. In other respects the British rules are applicable.

The Suez Canal Rules for arriving at the *gross tonnage* are much more exacting than the British rules in the matter of allowances for deck erections.

Previous to August, 1904, all closed-in spaces as well as partly closed-in spaces, such as poops, forecastles, alley-ways, etc. (fitted with coamings or channel bars), by which freight of any kind *could* be earned, were included in the *gross tonnage* measurement.

This, however, has been modified, and under the new rules such partly closed-in forecastles, poops and bridge spaces are no longer included in the gross tonnage.

The *lengths* of such exempted spaces to be subject to the following limitations:—

1. For a *forecastle* the length (measured from inside of stem at half the heigth) is limited to $\frac{1}{8}$ of the ship's length.*
2. For a *poop* the length (measured from inside of stern timber at half the height) is limited to $\frac{1}{10}$ of the ship's length.
3. For a *bridge* the length (measured from opening to opening at half the height) must not

---

* The length of the ship is measured for this purpose from the inside of stem at half the height of forecastle to the inside of stern timber or frame, at half the height of poop.

exceed the distance between the forward and after bulkheads of the main engine-room and stokehold.

Shelter-deck spaces, with the exception of that part immediately abreast the openings (if any) at the sides of the ship, are still included in the *gross tonnage.*

The volume of hatchways is treated the same as under British rules.

N.B.—Commanders of ships using the Suez Canal are specially warned against utilising any *wholly* or *partly exempted* spaces for the conveyance of cargo or stores under the penalty of having such spaces measured and added to the net tonnage; which, however, will not be subject to subsequent remission.

Spaces provided for carrying water-ballast, and used exclusively for that purpose, are in all cases exempted from measurement.

NET TONNAGE.

NET TONNAGE, although generally looked upon as the REGISTER TONNAGE, has really no higher claim to the latter designation than the GROSS or UNDER-DECK—all three being *registered* tonnages.

To the uninitiated the term *net tonnage* has no obvious meaning, for the simple reason that it conveys but a very loose idea either of the weight, capacity, or relative size of a ship. Indeed, it supplies little more than a convenient expression for the benefit of collectors of dues. Yet, from an economic point of view, the net tonnage is a factor of considerable moment to the ship-owner, by reason of its almost universal acceptance as a legal basis for levying port charges. The aim, therefore, should be to secure a maximum freight-earning capacity on a minimum net tonnage.

The shipbuilder, with the same object in view, makes a scientific study of the anomalies connected with our tonnage laws, and finds that certain permissible evasions enable him to build more economic and remunerative ships.

Not very long ago a Clyde firm turned out a clever design in the shape of a small steamer, the net tonnage of which, after the statutory deductions had been made, worked out a negative quantity. This was too much for the harbour authorities, who, thus deprived of their legal basis for assessment, lost no time in obtaining Parliamentary powers to meet such developments of design.

The lack of a universal system in arriving at the net tonnage is still a bone of contention among shipowners and harbour authorities; while the inability of the International Tonnage Committee to agree upon a common scheme for fixing the net tonnage has left each country free to specify its own deductions and qualifications, with the result that a very wide disparity sometimes exists between British and foreign net tonnage measurements, which is not always favourable to the British shipowner.

Cases might be quoted indefinitely of splendid vessels having to be laid up as "white elephants," simply because their relatively high net tonnage has rendered them unprofitable to run.

Net Tonnage Deductions under British Rules.

1. Space set apart for propelling power (see explanation, page 13).
2. Crew space, including officers' and engineers' quarters.
3. Spaces set apart for the working of helm, capstan anchors, etc., provided such spaces have been first measured for gross tonnage.
4. Master's accommodation.
5. Chart-room.
6. Boatswain's store-room.
7. Donkey-engine and boiler space when not reckoned as part of "actual engine-room"* for the purpose of arriving at the percentage allowed for propelling power.

A sailing ship is allowed a sail-room not exceeding $2\frac{1}{2}$ per cent. of her gross tonnage in addition to the above (always leaving out the *space set apart for propelling power*).

Net Tonnage Deductions under Suez Canal Rules.

The difference which often exists between the British and Suez Canal net-tonnage measurements is, in most cases, due to the system of fixing the *allowance for propelling power*, which, for Suez Canal purposes, may be determined either by actual measurement, or by what is known as the Danube Rule.

---

* By *actual engine-room* is meant the total space occupied by machinery and boiler, run for thrust, and shaft trunk. (Light and air space over engines and boilers may be included if desired, but the space must be reasonable in size, safe and seaworthy).

(*A*). Allowance for Propelling Power.

By Actual Measurement.

1. Engine-room (actual measurement), including shaft trunk, and all spaces set apart for the working of machinery and boilers.
2. Permanent coal bunkers.

By Danube Rule.

Engine-room (actual measurement), including shaft trunk, etc., and all spaces set apart for the working of machinery and boilers, plus 75 per cent. of the measured space for screw steamers and 50 per cent. for paddle steamers.

In any case the total deduction for propelling power must not exceed 50 per cent. of the gross tonnage of the ship.

(*B*). Minor Deductions as applied to both Sailing Ships and Steamers.

1. Berthing accommodation of crew (not stewards, cooks, or passengers' servants).
2. Berthing of officers (not the captain or purser).
3. Galleys and W.C.'s for the use of crew.
4. Covered and closed-in spaces above the upper-deck for working the ship, viz., chart-room,* wheel-house, etc.
5. Mess-room for officers and engineers not to exceed 400 cubic feet.
6. Mess-room for petty officers not to exceed 250 cubic feet.

---

* When the captain lodges in the chart-room a space of 300 cubic feet is allowed.

7. Bath-room for use of officers and engineers not to exceed 200 cubic feet.
8. Doctor's cabin, but only when occupied by the ship's doctor.

N.B.—The total space under the head of *minor deductions* not to exceed 5 per cent. of the gross tonnage of the ship.

French Tonnage.

Under the new French rules, which came into force in 1903 (revoked a year later), the deductions for net tonnage were allowed upon a most liberal scale, while the gross tonnage was slightly increased, the latter presumably on account of the French bounty system which is payable on the gross tonnage and mileage. The consequent shrinkage in the revenue derived from foreign shipping resulted in the abrogation of the 1903 rules, and now the British net tonnage measurement is accepted by the French Government for the purpose of levying port dues.

Italian Tonnage.

The Italian Rules for arriving at the *net tonnage* are practically the same as the British, except that (1) the crew space deduction above the upper-deck must not exceed 5 per cent. of the gross tonnage of the ship; anything in excess is not deducted from the gross tonnage. (2) *Closed-in spaces above deck* containing a portion of the machinery and boilers and serving as a protection to the same, are reckoned as part of gross tonnage, as well as part of "actual engine-room," but when such spaces exist only for the purpose of light and air, they are neither measured for gross tonnage nor "actual engine-room." The space occupied by a donkey boiler situated above the engine and boilers, but within the casing and connected with main engine, is also reckoned as part of gross tonnage and "actual engine-room" when estimating the percentage allowed for propelling space.

The volume of hatchways is totally disregarded under Italian rules.

The Under-deck Tonnage.

How to Measure and Calculate it.

The first tonnage obtained, in all cases, is the UNDER-DECK TONNAGE, which is simply the internal measurement of the ship below the tonnage-deck.* It enjoys the distinction of being the *only* tonnage definitely agreed upon by the International Committee.

The method of calculating the under-deck tonnage is practically the same as that employed in arriving at the displacement, *i.e.*, by Simpson's Rules, and if the worked-out examples in the succeeding pages are carefully followed no difficulty in grasping the principles need be experienced.

Provided with the usual measuring staff and tape (marked in feet and tenths), first take the LENGTH on the surface of the tonnage-deck, measured from points opposite where the wood-sparring meet underneath the tonnage-deck; or in the absence of wood sparring, where the angle irons or frames are joined.

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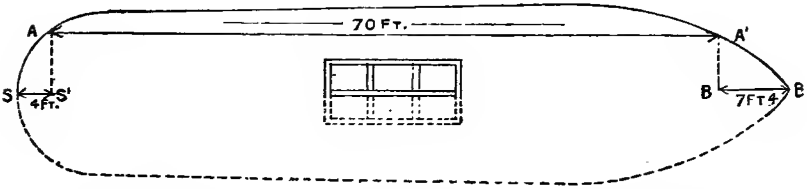
* The tonnage-deck is the upper deck in one, two, or three deckers, and the main deck in spar and awning deckers.

For Length.

FIG. 1.



$AA^1 = 70$ ft., $BB^1 = 7{\cdot}4$ ft., $SS^1 = 4$ ft. = total length, 81.4 ft.
Allowance made for rake* of stem and stern, – 0.4 ft.

LENGTH for tonnage, - - - - 81 ft.

Commencing at A (fig. 1) measure in a straight line outside all deck obstructions in the shape of hatches, deck-houses, etc., to A^1; then measure off SS^1 and BB^1. The sum of the three measurements thus found, less rake of stem and stern in thickness of deck plank, will be the length for tonnage; which, divided by 6†, gives the *common interval between areas.* Thus, 81 feet ÷ 6 = 13.5 feet *common interval.* Then at intervals of 13.5 feet, chalk off each point of division on the deck, and number according to requirements. Abreast each *station,* as numbered, take the perpendicular depth at the centre line of the ship, measured from the under side of tonnage-deck to the upper side of ceiling, at the

---

* Rake of stem and stern is the difference between the length as measured on the surface of tonnage-deck and that as measured underneath.

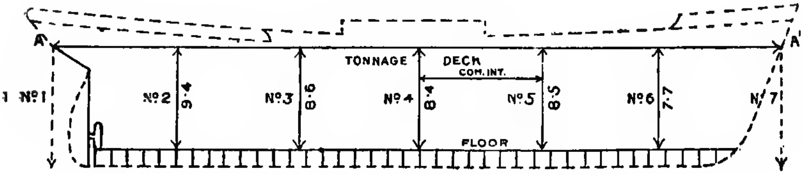
† RULE FOR FINDING THE COMMON INTERVAL BETWEEN AREAS.

For length of		50 feet or under	the divisor is		4
,,	,,	50 reet to 120 feet	,,	,,	6
,,	,,	120 feet to 180 feet	,,	,,	8
,,	,,	180 feet to 225 feet	,,	,,	10
,,	,,	225 feet or upwards	,,	,,	12

inside of limber strake,* as shown in fig. 2; not forgetting to deduct from each depth ⅓ of round of beam, and the average thickness of ceiling† on the floor girder.

For Depths.

FIG. 2.



Depths less ⅓ round of beam. } No. 1 = 0, No. 2 = 9.4, No. 3 = 8.6, No. 4 = 8.4, No. 5 = 8.5, No. 6 = 7.7, No. 7 = 0.

Length $A\,A^1 = 81$ feet, common interval between areas = 13.5 feet

Each DEPTH, measured as directed, is divided by 4 when the middle depth is not more than 16 feet, and by 6 when the same depth exceeds 16 feet. The quotient in each case will be the *common interval between breadths.*

THE BREADTHS from side to side (inside of wood-sparring)‡ are then taken at equidistant intervals, viz., from a to a^1, b to b^1, etc., as shown in fig. 3.

With the following data obtained from fig. 3 find the

---

* The depths are always taken from the top of a double bottom, allowing the usual deduction for thickness of ceiling (see footnote ‡ below). Peak tanks, used for water-ballast only, are reckoned as double bottoms.

† USUAL THICKNESS OF CEILING.

TONNAGE.	700	1000	1350	ABOVE 1350
Average Thickness of Ceiling betwixt Deck or Beams, -	IN. 2	IN. 2¾	IN. 3	IN. 3½
Ceiling below Hold Beams,	3¼	3½	4	4½
Bilge Plank and Limber Strake,	4½	5½	6¼	—

‡ In the absence of wood-sparring, the inside of the reverse frames will be the points of measurement.

area of the section (common interval between breadths = 2.1 feet) :—

	Breadths.		Feet.		Simpson's Multipliers.		Feet.
Section No. 4.	aa^1	=	15.8	×	1	-	15.8
	bb^1	=	15.8	×	4	-	63.2
	cc^1	=	15.8	×	2	-	31.6
	dd^1	=	15.7	×	4	- - -	62.8
	ee^1	=	11.4	×	1	- -	11.4

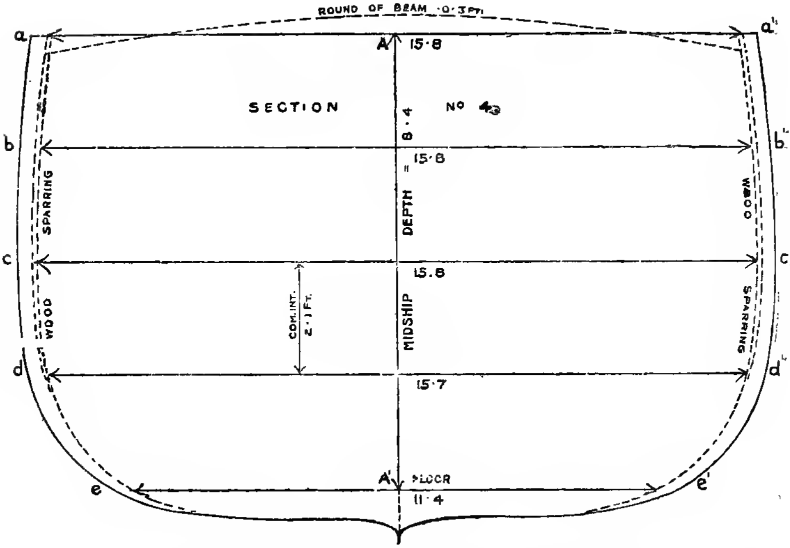
184.8

⅓ Common interval between breadths, = 0.7

129.36 area.

For Breadths.

FIG. 3.



The above calculation has to be repeated for sections Nos. 2, 3, 5, and 6 *(sections Nos. 1 and 7, being the extremities of the vessel, have a value of 0 assigned to them, so that the Simpson's Multipliers shall appear in their usual order.)* The AREAS are then arranged in column as shown below; each area, as numbered, is given its Simpson's multiplier, *i.e.*, the areas with even numbers are multiplied by 4, and those with odd numbers by 2, except first and last numbers, which have a multiplier of 1.

The sum of the products thus obtained, multiplied by $\frac{1}{3}$ Com. Int. between areas (13.5 feet, or $\frac{1}{6}$ the length), will give the volume under-deck in cubic feet. Divide this by 100 (tick off two whole numbers on the right), and you have the same volume in registered tons.

Thus—

SECTIONS.	AREAS.	SIMPSON'S MULTIPLIERS.	PRODUCTS.
No. 1 =	0	1	—
,, 2 =	78.31	4	313.2
,, 3 =	117.07	2	234.1
,, 4 =	129.36	4	517.4
,, 5 =	118.43	2	236.9
,, 6 =	70.40	4	281.6
,, 7 =	0	1	—

1583.2
$\frac{1}{3}$ Com. int. between areas = 4.5
79160
63328
Volume under Deck = 7124.40 cubic feet.
71.24 REGISTERED TONS.

The Gross Tonnage.

And how to Calculate It.

Our next example embodies the calculation of the gross tonnage as prescribed by Rule I.

In order to give this rule a simple and compact appearance, a screw tug-boat has been selected as an example—length, 81 ft., midship depth less than 16 ft.

By using the subjoined formula the risk of errors is considerably lessened, and the work may be effected without separating the quantities.

EXAMPLE OF RULE I.—THE CALCULATION OF UNDER-DECK AND GROSS TONNAGE.

Length on Tonnage Deck, 81 ft.; Com. Int. between Areas, 13.5 ft.; Round of Beam, 0.3 ft.

AREAS.		No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.		No. 7.	
DEPTHS.*		—		9.40		8.60		8.40		8.50		7.70		—	
COM. INT. Between Breadths.		—		2.35		2.15		2.10		2.12		1.92		—	
No. B'dths.	Simp's. Mult'pls.	B'dths.	Prods.	B'dths.	Prods.	B'dths.	Prods.	B'dths.	Prods.	B'dths.	Prods.	B'dths.	Prods.	B'dths.	Prods.
1	*1*	0	—	11.7	11.7	15.3	15.3	15.8	15.8	15.7	15.7	14.0	14.0	0	—
2	*4*	0	—	10.4	41.6	14.9	59.6	15.8	63.2	15.6	62.4	13.6	54.4	0	—
3	*2*	0	—	8.7	17.4	14.3	28.6	15.8	31.6	15.1	30.2	10.5	21.0	0	—
4	*4*	0	—	6.8	27.2	13.6	54.4	15.7	62.8	13.5	54.0	4.8	19.2	0	—
5	*1*	0	—	2.5	2.5	4.7	4.7	11.4	11.4	4.5	4.5	1.4	1.4	0	—
SUM OF PRODS.			0		100.4		162.6		184.8		166.8		110.0		0
⅓ COMMON INTERVAL Between Breadths.			—		0.78		0.72		0.70		0.71		0.64		—
AREAS.			0		78.31		117.07		129.36		118.43		70.40		0
Simpson's Mults.			*1*		*4*		*2*		*4*		*2*		*4*		*1*
ADD TOGETHER—PRODUCTS:					313.2		234.1		517.4		236.9		281.6		= 1583.2

Sum of Products (brought down), - - - - - - 1583.2 cubic feet.
⅓ Common interval between areas (13.5 ft. ÷ 3), - - 4.5 ,,

Under-deck measurement, - - - - - - - 7124.4 ,,
L. B. Ht.
Round-house (chart-room), 5.0 × 7.3 × 6.0, - - - 219.0 ,,
Excess of Hatchways, 8.0 × 6.0 × 1.5 = 72.0, - }
Less ½ % of gross tonnage, 38.6, - } = 33.4 ,,
Light and air space (fidley 237.0, skylight 117.0), - = 354.0 ,,

GROSS MEASUREMENT, - - - . - 7730.8 ,,

GROSS TONNAGE, = 77.31 REGISTERED TONS.

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* Less ⅓ of round-up of beam.

TO DETERMINE THE NET TONNAGE.

This is rather a tedious operation, requiring a considerable amount of attention to details, which, in their turn, demand a close study of the Rules laid down under secs. 78, 79, 80, and 81 of the Merchant Shipping Act.

The first *deduction* to receive our attention will be the "allowance for propelling power." This, as may be gleaned from the subjoined example, is not arrived at in the same way as the *minor deductions*, but has a peculiarly proportionate value of its own.

We have said that this *major* deduction affects the net tonnage much more than the *minor* deductions do, and that under British rules it presents not a few anomalies, which for obvious reasons, we refrain from discussing here.

To avoid complications, however, the reader is once more reminded that by "actual engine-room"* is meant the total cubic capacity of the following spaces:—

1. Main engine and boiler space.
2. Run for thrust.
3. Shaft trunk.
4. A reasonable space for the admission of light and air, if owner desires it to be measured.
5. Donkey-engine and boiler space when adequately connected with main engine and situated within the engine-room.

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* The length for "actual engine-room" in vessels with fore-and-aft fire grates is measured from the end of the boilers—adding to the length thus found the length of the fire grate plus one foot. When the fire grates are athwartships, no extra length is allowed; and in the case of the after cylinder or its valve casing, 4 ft. extra length is the maximum allowed. The open space abaft the engine-room in twin-screw steamers is only to be measured for "actual engine-room" for a height of 6 ft.; such space not to be used for keeping stores, etc.

RULES TO ARRIVE AT DEDUCTION ALLOWED FOR PROPELLING POWER.

I. When the tonnage of the *actual engine-room* amounts to between 13 and 20 per cent. of gross tonnage in screw steamers, and 20 and 30 per cent. in paddle steamers, the deduction allowed for propelling power shall be—

For screw steamers 32 per cent. of gross tonnage.
For paddle „ 37 „ „ „

II. Should the *actual engine-room* be *under* or *over* the above percentages of gross tonnage, the deduction for propelling power may be estimated at 1¾ times the tonnage of *actual engine-room* in screw steamers, and 1½ times in paddle steamers.

N.B.—When the tonnage of the *actual engine-room* is below the percentage of gross tonnage, as above, the Board of Trade have the option of adopting either of the two rules given, but when the tonnage of the *actual engine-room* exceeds the said percentage, the owner enjoys the option. If, however, he does not avail himself of the privilege, the measuring surveyor will adopt the first rule, viz., the 32 per cent. and 37 per cent.

EXAMPLE.

			Mean Length.		Mean Breadth.		Mean Height.	Cubic Contents.	Reg. Tons.
“Actual engine-room spaces.”	Boiler-room,	=	12.0	×	10.5	×	8.5	1071.0	10.71
	Engine-room,	=	12.0	×	12.0	×	8.0	1152.0	11.52
	Run for thrust,	=	2.0	×	3.5	×	3.5	24.5	0.24
	Shafting,	=	9.4	×	1.5	×	2.4	33.8	0.34
			Actual engine-room,						22.81 reg. tons.

Now, 22.81 tons being above 20 per cent. of gross tonnage, the *allowance for propelling power* may be calculated upon the 1¾ system, which gives us 39.92 tons; thus—

			Reg. Tons.
Allowance for propelling power (1¾ times 22.81),		=	39.92
Crew space, -	14.0 × 5.0 × 6.5	=	4.60
Master's accommodation, -	6.0 × 8.0 × 6.5	=	3.10
Engineer's ,,	6.0 × 7.0 × 6.5	=	2.70
Chart-room -	5.0 × 7.3 × 6.0	=	2.19
Boatswain's store-room,	6.3 × 10.5 × 2.0	=	1.30
Light and air space over engine and boiler (as measured for gross tonnage),		=	3.54
Total deduction, - - -		=	57.35
Gross tonnage, - - -		=	77.31
Net tonnage, - -		=	20.04

The advantages derived from the judicious application of the foregoing rules may be further illustrated in the following example:—

1. Take the case of a steamer of 2000 tons gross, with *actual engine-room* of 397 tons, which is a trifle under 20 per cent. of her gross tonnage, and therefore comes within the 32 per cent. rule for the allowance for propelling power.

Thus—

Gross tonnage = 2000 tons.
.32
∴ 32 % = 640 tons allowance for propelling power.

Now, if we could only bring the *actual engine-room* measurement up to 20 per cent. of gross tonnage, we should, under ordinary circumstances, estimate this deduction upon the 1¾ basis.

Just to show what can be done in this direction, let us suppose that the "light and air space" over engines and boilers is increased by 11 tons, thus bringing up the gross tonnage to 2011 tons, and the *actual engine-room* to 408 tons (a little above the 20 per cent. of gross tonnage required), and we have the following interesting result:—

Increased actual engine-room measurement, -	408 tons.
Plus ¾,	306 ,
Deduction by the 1¾ system,	714.0 ,,
,, ,, 32 % system (as estimated for 2011 gross tonnage),	643.5 ,,
In favour of 1¾ system,	70.5 ,,

After deducting the 11 tons which were added to the gross tonnage, we find that we have reduced our net tonnage by about 60 tons. Thus we have an increase of 11 tons in the original gross tonnage and a reduction of 60 tons in the net tonnage.

RULE II. FOR MEASURING TONNAGE.

When it is not possible to measure a ship for tonnage by Rule I., which happens when there is cargo or ballast on board, an approximate method, officially called Rule II., is employed. The tonnage certificate issued in such a case is only provisional, and the vessel must be remeasured at the first opportunity.

The data required for this purpose are—

1. *Main girth* (measured under keel from deck to deck at ship's side).
2. *Main breadth* (measured across the deck from side to side).
3. Length (as for Rule I.)
4. The decimal factor prescribed by the Act.

FORMULA FOR IRON OR STEEL SHIPS.

$\frac{1}{2}$ (main girth + main breadth)^2 × length × ·0018* = under-deck tonnage.

Fishing boats are generally measured under Rule II.

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* The decimal factor prescribed for wooden ships is ·0017.

FREEBOARD.

Definition of Freeboard—Limitations to Loading—Various Load-Lines—Deck Line—Assignment of Freeboard—Deductions and Allowances—Freeboard Tables—Data to Determine Freeboard—Examples to find Under-Deck Tonnage—Winter and Summer Freeboards of Various Types of Ships—Deduction from Winter Freeboard—Table A, Relating to Cargo-Carrying Steamers—Table B, Relating to Spar-Decked Steamers—Table C, Relating to Awning-Deck Steam Vessels—Table D, Relating to Iron or Steel Sailing Ships—Table below Mean Sheer—Table Showing Increased Submersion or Reduction in Freeboard.

FREEBOARD is the nautical expression for a ship's clear side as measured from the top of the deck at the sides down to the water-line amidships.*

The minimum freeboards enforced by Act of Parliament on all British ships (except coasting vessels under 80 tons† net tonnage, fishing boats and pleasure yachts) as a margin for safety vary according to the type of vessel to be dealt with, taking into account the structural arrangements, strength, trade engaged in, and the season of the year in commission.

The limitations to loading, as laid down by the Load-line Act, are represented by a *disc* and a number of horizontal‡ lines called *maximum load lines.* These are cut and painted on each side of the ship amidships.

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* The middle of the ship's length taken at the load-water line.

† Coasting steamers under 80 tons will not be exempted from the load-line regulations under the new Merchant Shipping Act of 1907, special exceptions being granted to any class of steamer so long as they do not carry cargo.

‡ The line of even draughts.

(*a*) The *disc* to be 12 inches in diameter.

(*b*) The *principal line* or "bar" to be 18 inches long and 1 inch broad, drawn horizontally in such a manner that its upper edge shall pass through the centre of the disc.

(*c*) The remaining *load-lines* to be 9 inches long and 1 inch broad, placed at a distance of 21 inches forward of the centre of the disc, the group when complete forming a design resembling a gridiron.

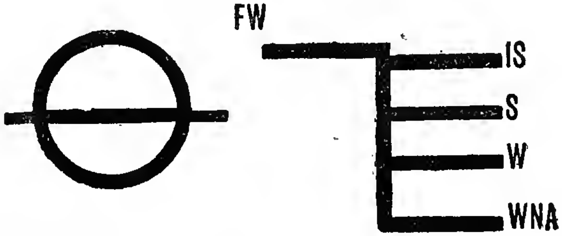
N.B.—The centre of the disc indicates the maximum summer load-line in salt water (specific gravity, 1.025).

The adjoining diagram (fig. 4) will show at a glance the order in which the various load-lines are arranged, not forgetting that the upper edge of each line must be taken as the point of measurement.

Fig. 4.

For Steamships.

Starboard Side.



DISTINGUISHING LETTERS :—

F. W.—Fresh Water.
I. S.—Indian Summer.
S.—Summer (centre of disc).
W.—Winter.
W. N. A.—Winter, North Atlantic.

Sailing ships engaged in the foreign trade are not compelled to have the *W.* and *I. S.* marks, while a home trade sailing ship need only have the *F. W.* mark in addition to the usual disc and bar.

THE DECK LINE.

The first thing a Board of Trade Surveyor does after assigning freeboards to a ship, is to fix upon a position for the Deck Line, which shall be 12 inches long and 1 inch broad, marked longitudinally on the outside plating amidships as follows :—

1) On a flush-decked ship: at the intersection of upper-deck and outside plating.

(2) On a spar-decked ship: at the intersection of spar-deck and outside plating.

(3) On an awning-decked ship: at the intersection of main-deck and outside plating.

(4) On a turret ship: at the intersection of turret-deck and outside plating.

The foregoing rules apply to all ships, whether the deck be of wood, iron, or part iron and part wood, and in all cases the upper edge of the deck line is to be level with the upper side of the deck plank next to the gutterway.*

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*In vessels with uncovered iron or steel decks a width of gutter may be assumed as follows :—

Vessels of 42 ft. beam and above allow 21 inches for width of gutter.
,, 24 ft. ,, under ,, 12 ,, ,,
,, between 24 and 42 ft. beam allow ½ inch for every foot of beam.

THE ASSIGNMENT OF FREEBOARD.

Despite the fact that the rules for assigning freeboards are based on the simple principle of proportionate buoyancy, their application *will* sometimes give trouble; their complexity arising mostly from the numerous "new designs" to be dealt with.

The whole question, however, centres upon the ratio which the reserve buoyancy shall bear to the total buoyancy, in order to ensure what is *officially* considered a sea-worthy condition.

To detail the tedious work involved in determining the deductions and allowances made on account of strength of structure, disposition of reserve buoyancy, etc., would mean a reproduction of a number of sections of the Merchant Shipping Act. This is hardly necessary here, and it will be sufficient for our present needs if the Freeboard Tables are clearly explained leaving no doubt as to their correct application.

The Freeboard Tables issued by the Board of Trade are framed for four classes of vessels, and are arranged in alphabetical order as follows:—

Table ***A*** provides for flush-decked steamers and others not having spar or awning decks.

Table ***B*** provides for spar-decked steamers.

Table ***C*** provides for awning-decked steamers.

Table ***D*** provides for sailing ships.

These tables are subject to certain modifications when freeboards are assigned to vessels of a type other than that which they are framed for. For instance, a departure is necessary for well-decked ships, part awning deckers, turret deckers, etc.

In some cases important allowances are made on account of structural strength, excess of sheer, camber, etc., supplementary rules being provided from time to time to meet the requirement of new designs.

The data required for determining the freeboards by tables are:—(1) type of ship; (2) dimensions; (3) mean sheer; (4) round of beam; (5) description of deck*; (6) coefficient of fineness.

(1) The *type of ship* must be agreed upon in order to ascertain which table will meet the case, and whether any modifications are necessary.

(2) The *length for freeboard* is taken at load-water-line; measured from the fore-side of the stem to the after-side of the stern post in sailing ships, and the after post in steamers. The *breadth for freeboard* is the maximum breadth and is measured from outside shell plating or planking. The depth for freeboard when employed for finding the coefficient of fineness will be the *depth of hold* measured from the top of upper-deck beam at side, to the top of the floors or tank tops in steamers, and to the top of ceiling in sailing ships. When the vessel's sheer is more than the standard sheer given in table, add $\frac{1}{3}$ of their difference to the depth of hold as measured, but when the standard sheer is the greater deduct $\frac{1}{3}$ of their difference from the depth of hold. The *moulded* depth must always be used to ascertain the freeboard allotted by the Free-

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* Where the statutory deck-line is placed.

board Tables, and is taken from the top of upper-deck beam at side in flush-decked vessels, and from the top of main-deck beam in spar or awning deckers, to the top of keel in iron or steel vessels, and to the lower edge of rabbet at keel in wooden or composite ships.

(3) Anything in excess of the *mean sheer* prescribed for flush-decked vessels (see Table of Mean Sheer, page 48) is allowed as a reduction in freeboard at the rate of $\frac{1}{4}$ of such excess. For example, a flush-decked ship having a mean sheer of 8 inches in excess of requirements would be entitled to a reduction of 2 inches in freeboard. If, on the other hand, the sheer should be less than the standard given then $\frac{1}{4}$ of the deficiency would be added to the freeboard. The rules may be slightly modified to meet the requirements of vessels having poops, forecastles, raised quarter decks, etc., but no notice is taken of any excess of sheer in spar or awning deckers.

(4) The *round of beam* allowed is at the rate of $\frac{1}{4}$ of an inch for every foot of the length of 'midship beam. Should the round up exceed this standard, then $\frac{1}{2}$ of such excess is deducted from the freeboard, and in the case of the *round up* being less than the amount prescribed, $\frac{1}{2}$ of the deficiency is added to the freeboard. No notice will be taken of the *round up of beam* in spar or awning-decked vessels.

(5) In the case of uncovered iron or steel decks the usual thickness of wood deck prescribed by Lloyd's rules, less thickness of stringer

plate, is deducted from the freeboard. For a partly covered deck a deduction proportionate to the length of deck covered is allowed to count.

(6) The *coefficient of fineness** necessary for the application of the Freeboard Tables is obtained by dividing the cubic capacity under deck (under-deck tonnage × 100) by the product of the length, breadth, and depth of hold.

$$\text{Coefficient of fineness} = \frac{\text{Under-deck tonnage} \times 100}{L \times B \times D}$$

EXAMPLE I.

(*a*) Under-deck tonnage, 1542 registered tons, length at L.W.L. 276 ft., extreme breadth 38 ft., depth of hold 21 ft., and moulded depth 23 ft. Find the coefficient of fineness, also the winter freeboard.

$$\frac{1542 \times 100}{276 \times 38 \times 21} = \cdot 7 \text{ coefficient of fineness.}$$

Turning to Table *A* (page 44), with coefficient of fineness ·7, length 276 ft., and moulded depth 23 ft., we get a winter freeboard of 4 ft. 7½ ins.

(*b*) Winter freeboard by Table *A* being 4 ft. 7½ ins. (as above), mean sheer 45 ins., length of 'midship beam 34 ft., and *round up of beam* 4 ins. Find the corrections to be applied.

Mean sheer for 276 ft. length (Sheer Table, page 48), = 38 ins.
Actual sheer of ship, - - - = 45 ins.
4) 7 ins. excess.
Correction for excess of sheer to be applied to winter freeboard, = 1·75 ins.

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* In some cases the registered under-deck tonnage, and depth of hold, when used for obtaining the coeff. of fineness, will require a little adjusting; for instance, when the double bottom extends the whole length of the ship, or when unusually high floors exist, the coeff. of fineness will in most cases be slightly increased, but no general rule for guidance is given, the coefficient required being the one a vessel would have if framed on the ordinary transverse principle.

Round of beam (34 ft. length of 'midship beam) allowed at the rate of ¼ inch per foot of length of beam,	$\frac{34}{4} = 8{\cdot}5$ ins.
Actual round of beam, - - -	4·0 ins.
	2) 4·5 deficit.
Correction to be added to winter freeboard on account of round of beam,	2·25 ins.

		Ft.	Ins.
Winter freeboard by Table *A*, - -		4	7½
Correction for deficiency in camber or round of beam,	+ 2¼ ins.	+	0½
Correction for excess of sheer,	— 1¾ ins.		
Corrected winter freeboard, - -		4 ft.	8 ins.

With the corrected winter freeboard (as above), find the remaining freeboards prescribed by the Load-Line Act.

	Ft.	Ins.
W.—Corrected winter freeboard,	4	8
Deduction for summer voyage,	0	3
S.—Summer freeboard,	4	5
Deduction for Indian summer,	0	3
I.S.—Indian summer freeboard, -	4	2

W.N.A.—Winter North Atlantic (add 2 inches to winter freeboard), = 4 ft. 10 ins.

F.W.—Deduct 4 inches for fresh water (see Table, page 48, moulded depth 23 ft.)

N.B.—***W.***—Applies to voyages made from European and Mediterranean ports between 1st October and 31st March.

S.—Applies to all parts from 1st April to 30th September (see Tables *A, B,* and *C*).

I.S.—Voyages made during fine weather season between Suez and Singapore (approximately from October to May). For *I. S.* freeboard, double the *allowance* for summer voyages is deducted from the winter freeboard.

W.N.A.—Applies to steamers—not "well deckers" for which a special Table is provided (see page 46)—of 330 ft. in length and under, and all sailing ships, regardless of length or size, making voyages within the limits of Cape Hatteras and the Mediterranean between October and March inclusive. 2 inches is added to winter freeboard for steamers, and 3 inches for sailing ships.

EXAMPLE II.

Find the winter and summer freeboards of a spar-decked steamer—length 420 ft., breadth 50 ft., moulded depth 27 ft., and coefficient of fineness 0·8.

Turning to Table *B* (page 43), with moulded depth of 27 ft., length 408 ft., and coefficient ·8, we obtain a winter freeboard of 10 ft. 1½ ins. (measured to the top of spar deck), and a correction (given at foot of table) of 1·4 in. for every 10 ft. of length—to be added or subtracted as the case may be.

	Ft.	Ins.
Winter freeboard for 408 ft. length, moulded depth, 27 ft.,	10	1·5
Corr. for 12 ft. extra length* $\left(\frac{12 \times 1\cdot4}{10}\right)$,	+	1·7
Winter freeboard for length of 420 ft.,	10	3·2
Deduction for summer voyages,		−6
Summer freeboard,	9 ft.	9·2 in.

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*The Freeboard Tables are computed for ships having their moulded depth equal to $\frac{1}{14}$ of their length. When the length exceeds that corresponding to the moulded depth the correction (given at foot of table) will be added to winter freeboard, and subtracted from it when it falls short of the length, *i.e.*, plus when working ahead, and minus when working back.

EXAMPLE III.

Find the winter and summer freeboards of an awning-decked steamer—length 310 ft., breadth 40 ft., moulded depth 25 ft., and coefficient of fineness 0·8.

Turning to Table ***C*** (page 46), with coefficient ·8, moulded depth 25 ft., and length 300 ft., we get the corresponding freeboard of 3 ft. 3½ ins., but as the length is 10 ft. more than that given in the Table, the usual correction is applied.

Thus :—

	Ft.	Ins.
Winter freeboard by Table ***C*** for 300 ft. length,	2	8·0
Correction for 10 ft. of length,		+ 0·7
Corrected winter freeboard, - - - - -	2	8·7
Deduction for summer voyages, -		– 5·0
Summer freeboard, -	2 ft.	3·7 ins.

EXAMPLE IV.

(TABLES ***A*** AND ***C***).

Find the winter and summer freeboards of a steamer 300 ft. long, 25 ft. moulded depth, and ·7 coefficient of fineness, having poop and bridge house extending forward of engine and boiler room, and topgallant forecastle; the combined length of these deck erections being 240 ft., or $\frac{8}{10}$ the length of the vessel; the mean sheer measured forward and aft being 48 inches.

Mean sheer by table (page 48), flush deck,	40 ins.
,, of vessel, - -	48
Excess of sheer, - -	4) 8 ins.
Deduction on account of excess of sheer, -	2 ins.

	Ft. Ins.
Freeboard by Table *A*, - -	5 4
Correction for excess of sheer,	−2
Corrected freeboard by Table *A*,	5 2
Freeboard by Table *C*,	2 5·5
Difference, -	2ft. 8·5 ins. or 32·5 ins.
Deck erections* equal to $\frac{8}{10}$ the length of the vessel, deduct 70 per cent. of the difference by Tables *A* and *C*,	× ·70
$70^{\circ}/_{\circ} =$	22·75 ins.
	= 1 ft. 10·75 ins.
Corrected freeboard by Table *A* (as above),	5 ft. 2·0 ins.
Winter freeboard, -	3 ft. 3·25 ins.
Deduction for summer voyages, -	−3 5 ins.
Summer freeboard,	2 ft. 11·75 ins.

EXAMPLE V.

Find the winter freeboard of a vessel 320 ft. long, 25 ft. moulded depth, and coefficient of fineness 0·8; the enclosed, but disconnected, deck-erections in the shape of poop, bridge house (covering engine and boiler openings) and topgallant forecastle having a combined length of 160 ft., or $\frac{6}{10}$ the length of the ship; the iron main deck not covered, and the sheer of a normal character as per table.

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* The deduction on account of deck erections in the shape of long poops or raised quarter decks extending forward of engine and boiler room, with topgallant forecastle, are as follows:—

When the deck erections (4 ft. high or above) have a combined length of $\frac{9}{10}$ the length of the vessel, deduct 85 per cent. of the difference between the freeboard found by Table *A* (corrected for sheer) and that found by Table *C*.

When deck erections, etc., are $\frac{85}{100}$ the length of vessel deduct 80 per cent.
" " $\frac{8}{10}$ " " " 70 "
" " $\frac{7}{10}$ " " " 55 "
" " $\frac{6}{10}$ " " " 40 "

	Ft.	Ins.
Freeboard by Table *A* (moulded depth 25 ft., length 300 ft.),	5	8
Freeboard by Table *C* (moulded depth 25 ft., length 300 ft.), -	2	8
Difference, -	3	0
	12	
	36 inches.	

Deck erections* (disconnected) equal to $\frac{6}{10}$ length of ship, deduct 40 per cent.,	·40
12)	14·4 inches.
Deduction,	1 ft. 2·4 ins.
Freeboard by Table *A* (as above), - -	5 ft. 8·0 ins.
	4 ft. 5·6 ins.
Length Correction $\frac{20 \times 1\cdot3}{10} = 2\cdot6$ (½ allowed)†	+ 1·3 ins.
Freeboard corrected for length in excess,	4 ft. 6·9 ins.
Correction for uncovered main deck for $\frac{6}{10}$ the length $= \frac{6}{10} \times 3\frac{1}{2}$‡, - -	− 2·1 ins.
Reduced winter freeboard, - -	4 ft. 4·8 ins.

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* Poops, topgallant forecastles, and bridge houses efficiently enclosed with iron bulkheads at the ends, but disconnected, are allowed the following deductions when their combined length cover :—

$\frac{9}{10}$	length of vessel	75°/。	diff.	of freeboard	by Table *A*	(corr. for sheer) and	Table *C*.
$\frac{8}{10}$	,,	60°/。	,,	,,	,,	,,	,,
$\frac{7}{10}$	,,	50°/。	,,	,,	,,	,,	,,
$\frac{6}{10}$	,,	40°/。	,,	,,	,,	,,	,,
$\frac{5}{10}$	,,	32°/。	,,	,,	,,	,,	,,
$\frac{4}{10}$	,,	25°/。	,,	,,	,,	,,	,,

† For erections extending over $\frac{6}{10}$ the length of the vessel, the correction for length will be ½ of that given at foot of Table *A*.

‡ Deck erections covering $\frac{6}{10}$ of the length; and as 3½ in. is allowed for full length of uncovered deck, therefore $\frac{6}{10}$ of 3½ = 2·1 in deduction.

The deductions made on account of minor deck erections are as follows :—

(a) For a vessel with topgallant forecastle and bridge house only, the combined length of which is $\frac{5}{10}$ the length of the ship, deduct 30 per cent. of the difference between freeboards in Table ***A*** (corrected for sheer and length) and Table ***C*** (corrected for length).

If $\frac{4}{10}$ the length of vessel, deduct 24 per cent., etc.
If $\frac{3}{10}$,, ,, ,, 19 ,, ,,

(b) For a steamer with a short poop or raised quarter-deck (not less than standard height, see page 31) and topgallant forecastle, the combined length of such enclosed erection covering $\frac{4}{8}$ the length of the vessel, deduct 32 per cent. of the difference between the freeboards given by Table ***A*** (corrected for length), and Table ***C*** (corrected for length).

If $\frac{3}{8}$ the length of vessel, deduct 24 per cent. of diff., etc.
If $\frac{2}{8}$,, ,, ,, 16 ,, ,, ,,
If $\frac{1}{8}$,, ,, ,, 8 ,, ,, ,,

When the length of erections is less than $\frac{1}{8}$ the length of the ship, the allowance will be in proportion to the 8 per cent. allowed.

When erections are limited to a forecastle only, the deduction shall be $\frac{1}{2}$ of that allowed for vessels with short poops and topgallant forecastles.

Example VI.

Find the winter North Atlantic and summer freeboards of a sailing ship (iron) 315 ft. long, 30 ft. moulded depth, and coefficient of fineness ·7; the combined length of poop and forecastle efficiently enclosed being 118 ft.; mean sheer 6 inches in excess of that given by Table.

	Ft.	Ins.
Freeboard by Table *D* (moulded depth 30 ft., length 300 ft.), -	6	11
Excess of sheer, 6 in., ∴ $\frac{6}{4} = 1\frac{1}{2}$ in., -		− 1·5
Freeboard corrected for sheer, -	6	9·5
Correction for length, $\frac{15 \times 1\cdot5}{10} = 2\cdot25$		+ 2·25
Freeboard corrected for length, -	6	11·75
Deck erections 118 ft. or $\frac{3}{8}$ the length of vessel, deduct 10 per cent. Thus: $\frac{6\text{ ft. }11\cdot75\text{ in.}}{10} = 8\cdot375$ inches (see Rule),		− 8·38
Summer freeboard (centre of disc),	6	3·37
Additional for *W. N. A.*,		+ 3
W. N. A. freeboard, - - -	6	6·37

RULES FOR DECK ERECTIONS, ETC., IN SAILING SHIPS.

(*a*) Sailing vessels with efficiently closed-in (with bulkheads) topgallant forecastles and poops have their deductions allowed for freeboard as follows :—

12°/o deduction when combined length of erections is $\frac{4}{8}$ length of vessel.
10°/o ,, ,, ,, $\frac{3}{8}$,,
8°/o ,, ,, ,, $\frac{2}{8}$,,
6°/o ,, ,, ,, $\frac{1}{8}$,,

When less than $\frac{1}{8}$ the allowance shall be proportionate to the 6 per cent. as above.

(*b*) The freeboard of a sailing ship with a bridge house in addition to poop, or forecastle, or both, is found by Tables *A* and *C*, as in the case of a steamer with similar deck erections.

When such deck erections efficiently enclosed extend $\frac{5}{10}$ the length of the ship, the maximum deduction of 30 per cent. may be made in the freeboard, and so on in proportion.

The value of the length of a topgallant forecastle, not efficiently closed-in, is not estimated in full beyond $\frac{1}{8}$ the length of the ship; anything in excess will have half value.

Thus, a vessel 304 ft. long with an open forecastle of 100 ft. in length: the value of such length of forecastle would be: $\frac{304}{8} = 38 + \frac{1}{2}(100 - 38) = 69$ ft., value of length of forecastle.

A full value is always given to efficiently closed-in structures.

TURRET-DECK VESSELS

and Vessels of a Similiar Type.

The following rules are framed for a turret vessel, the height of the turret erection not being less than $\frac{1}{4}$ the moulded depth, and its breadth not less than $\frac{1}{2}$ the extreme breadth of the ship; hatch coamings not less than 2 ft. high, engine and boiler casing not less than 4 ft. high, and all openings in the harbour deck to be securely closed (and watertight) by means of iron or steel plates, not less in thickness than the harbour deck plates.

The freeboards for a turret ship are arrived at much in the same way as in the case of a vessel having ordinary deck erections, *i.e.*, by referring to Tables **A** and **C**, except that *length* of turret, employed for estimating the percentage of deduction, has a proportionate value assigned to it, and is officially designated the *effective* length, *e.g.*,

$$\text{Effective length} = \frac{\text{Actual length of turret} \times \text{Mean breadth of turret}}{\text{Breadth of ship (amidships).}}$$

The above formula holds good for *effective* length of poops or forecastles, except that the "*breadth* of ship" used as a denominator is, in this instance, taken at the fore end of a poop, and at the after end of a forecastle.

(1) When the effective length of a turret is $\frac{6}{10}$ the length of the vessel, deduct from freeboard

found by Table *A*, 45 per cent. of the difference between the freeboards prescribed by Table *A* (corrected for sheer) and Table *C*; the deduction increasing 10 per cent. for every $\frac{1}{10}$ increase in *effective* length of turret.

(2) Where a poop or a forecastle, or both, are erected on top of the turret deck, and the effective length of such erections is equal to $\frac{1}{8}$ the length of the ship, deduct 8 per cent. of the difference between the freeboards given in Table *A* (corrected for sheer) and Table *C*. A greater or less effective length is treated in proportion, —this deduction, however, must not exceed 10 per cent. of the difference between freeboards given in Tables *A* and *C*.

EXAMPLE VII.

Find the winter freeboard of a turret-deck steamer—length 380 ft., extreme breadth 51 ft., moulded depth 28 ft., length of turret 358 ft., mean breadth of turret 27 ft., coefficient of fineness 0·78, mean sheer 56 ins.

	Ft.	Ins.
Freeboard by Table *A* (moulded depth 28 ft., length 336 ft.), -	6	9·5
Mean sheer by Rule, 48 ins., ,, of ship, 56 ins., { Excess, 8 ins. ÷ 4 } =		−2·0
Freeboard by Table *A* corrected for sheer,	6	7·5
Freeboard by Table *C* (moulded depth, 28 ft.), - -	3	8.0
Difference, -	2	11·5
	or	35·5 ins.
$\frac{27 \times 358}{51}$ = 190 ft. effective length of turret, or $\frac{5}{10}$ the length of the ship gives, by Rule, a deduction of 45 per cent. of difference, -		·45
		1775
		1420
		15·975 ins.
Deduction = 45°/₀ of difference =	1 ft.	4 ins.
Freeboard by Table *A* (corrected for sheer), -	6 ft.	7·5 ins.
	5 ft.	3·5 ins.
Corr. for length Table *A*, $\frac{44 \times 1·4}{10}$ = 6·16 (less ¼*)		+4·6 ins.
Freeboard corrected for length,	5 ft.	8·1 ins.
Corr. for uncovered deck, $\frac{5}{10} \times 3\frac{1}{2} = 1·75$		−1·75 ,,
Winter freeboard required, - -	5 ft.	6·3 ins.

---

* Correction for length as given in Table *A* is reduced by ¼ when the breadth of the turret is $\frac{5}{10}$ the breadth of the ship, and by ½ when the breadth of the turret is $\frac{6}{10}$ the breadth of the ship or more.

The same Rules as prescribed for spar and awning-decked ships apply to turret ships with regard to unsheathed iron or steel harbour decks. The freeboards are measured from the line of the turret deck, which is the base line of the turret passing through a point where a vertical line drawn at $\frac{1}{4}$ the breadth of the vessel amidships cuts the upper surface of the deck.

The moulded depth is measured from this point of intersection to the top of the keel.

The coefficient of fineness is increased by about ·03 in ordinary cases where the vessel is of a rounded form at the gunwale.

When using the buoyancy method of determining freeboards, 30 per cent. of the volume of the turret (measured from above base line) is to be deducted from the reserve buoyancy prescribed by tables. In this case no correction is necessary on account of unsheathed iron or steel harbour decks.

When a vessel does not conform to standard proportions, full particulars of such departure must be submitted to the Board of Trade before freeboards can be assigned.

RULES FOR SHELTER-DECKED STEAMERS.

The freeboard of a shelter-decked steamer must not be less than the freeboards assigned to a complete awning-decked steamer of the same dimensions.

The shelter-deck Rules are framed for a vessel having a complete superstructure covering the *full* length of the vessel; the deck to be unbroken at the sides, but having one or more openings along the middle line of deck; such openings *not* to have permanent means of closing, in the shape of hatchways fitted with coamings, cleats, fore and afters, beams, etc.

Portable planks and beams—the latter not more than 5 ft. apart—and the deck supported from underneath, are considered as an *efficient* though only a temporary means of closing the shelter-deck openings.

The freeboards are arrived at by the application of Tables *A* and *C*, as in the case of vessels with poops, forecastles and bridge houses.

By treating each opening in the shelter deck as an open well, the *effective* length of shelter-deck erection may be determined in much the same way as the effective length of poops, forecastles, and bridge houses (open or closed), *i.e.*, the estimated length of openings is deducted from the length of the structure, which gives an assumed length, to this is added a proportion of the length of the opening as follows :—

When the deck openings are provided with "temporary means of closing," as described above, add ½ the difference between the length as computed, and the length of the ship; but when the same openings are *not* provided with "temporary means of closing," add ¼ the difference, etc.

In case the opening should be wider than ½ the breadth of the vessel the addition to assumed length is to be in proportion, according to means of closing.

The correction for length is to be ½ that specified by Table **A** when effective length is not less than 6/10 the length of the ship.

Where there is only one opening, the allowance for deck-erections will be in accordance with regulations prescribed for a vessel with a forecastle, long poop, or raised quarter-deck—the latter connecting with bridge-house. (Freeboard Tables par. 11). But in the case of more than one opening, the allowance for deck erections will be in accordance with regulations affecting poops, bridge-houses and forecastles disconnected. (See Freeboard Tables par. 12).

The deduction for summer voyages shall be the mean of the deductions for summer voyages specified in Tables **A** and **C**.

Freeing ports are not enforced except when the deck-openings are not provided with "efficient means of closing," but should the freeing ports be required they must be of the area prescribed; the minimum being:—

4·5 sq. ft. for length of opening in shelter deck of 5 ft.
6·5 ,, ,, ,, ,, 10 ft.
7·5 ,, ,, ,, ,, 15 ft.
8·5 ,, ,, ,, ,, 20 ft.
9·0 ,, ,, ,, ,, 25 ft.

½ per cent. of the vessel's moulded depth will be added to the freeboard when the area of freeing ports is less than the above, provided the vessel has more than one shelter-deck opening, as prescribed by Freeboard Tables, par. 12, for disconnected erections.

PART-AWNING-DECK VESSELS having a raised Quarter-Deck of less than the Standard Height of 4 ft., and extending over $^2/_5$ of the Length, will have their Allowance for such Erections reduced as per Table below:—

HEIGHT OF RAISED QUARTER DECK.		MOULDED DEPTH.						
		FT. IN. 10 0	FT. IN. 12 0	FT. IN. 14 0	FT. IN. 16 0	FT. IN. 18 0	FT. IN. 20 0	FT. IN. 22 0
FT.	IN.	IN.	IN.	IN.	IN.	IN.	IN.	IN.
3	6	—	¼	½	½	½	¾	¾
3	0	½	¾	1	1	1¼	1½	1¾
2	6	1	1¼	1½	1¾	2	2½	3
2	0	1½	1¾	2¼	2¾	3¼	3¾	4½
1	6	2	2½	3	3¾	4¼	5	6

PART AWNING-DECKED VESSELS WITH RAISED QUARTER-DECKS.

The following reductions are made from freeboards prescribed by Table *C* in part awning-decked vessels with raised quarter-deck, the break of which is $\frac{1}{10}$ of the vessel's length abaft amidships, the strength maintained as per Lloyd's Rules.

Number of plating under 18,000 deduct 2½ ins.
,, ,, 18,000 to 21,000 ,, 3 ins.
,, ,, 21,000 to 27,000 ,, 3½ ins.

Twice the above allowance is made when the raised quarter-deck is not less than $\frac{3}{10}$ the length of the vessel abaft amidships.

The standard height of raised quarter-deck in the above type of vessel is 4 ft. The allowance for this erection will be diminished if of less height than 4 ft. and extending over $\frac{4}{10}$ of the length. (See page 36, Freeboard Tables, 1906.)

Well-Deck Steamers.

ADDITIONAL FREEBOARD FOR WINTER NORTH ATLANTIC.

Proportion between Length of Ship and Length of Erections,	60%	65%	70%	75%	80%
	IN.	IN.	IN.	IN.	IN.
Length of vessel, 180 ft.,	4	3½	3	2½	2
,, ,, 220 ,,	3½	3½	3	2½	2
,, ,, 260 ,,	3½	3	2½	2	2
,, ,, 300 ,,	3	3	2½	2	2

Table A.

RELATING TO CARGO-CARRYING STEAMERS NOT HAVING SPAR OR AWNING DECKS.

(SECTION REPRODUCED FOR WORKING THE EXAMPLES).

FREEBOARD MEASURED FROM THE TOP OF UPPER DECK.

Percentage of Reserve Buoyancy, - -	27·8	28·1	28·3	28·6	28·9	29·2	29·5	29·8	30·1	30·4	30·8	31·1
Length (in feet), - -	270	276	282	288	294	300	306	312	318	324	330	336
Moulded Depth (in feet and inches), - -	FT. IN. 22 6	FT. IN. 23 0	FT. IN. 23 6	FT. IN. 24 0	FT. IN. 24 6	FT. IN. 25 0	FT. IN. 25 6	FT. IN. 26 0	FT. IN. 26 6	FT. IN. 27 0	FT. IN. 27 6	FT. IN. 28 0
	WINTER FREEBOARD (in feet and inches).											
	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.
Coeff. of Fineness, ·68	4 4½	4 6½	4 8½	4 10½	5 1	5 3½	5 5½	5 8	5 10	6 0½	6 3	6 5
,, ,, ·70	4 5½	4 7½	4 9½	4 11½	5 1½	5 4	5 6	5 8½	5 10½	6 1	6 3½	6 6
,, ,, ·72	4 6	4 8	4 10	5 0	5 2½	5 5	5 7	5 9½	5 11½	6 2	6 4½	6 7
,, ,, ·74	4 7	4 9	4 11	5 1	5 3	5 5½	5 7½	5 10	6 0½	6 3	6 5½	6 8
,, ,, ·76	4 7½	4 9½	4 11½	5 1½	5 4	5 6½	5 8½	5 11	6 1½	6 4	6 6½	6 9
,, ,, ·78	4 8½	4 10½	5 0½	5 2½	5 4½	5 7	5 9	5 11½	6 2	6 4½	6 7	6 9½
,, ,, ·80	4 9	4 11	5 1	5 3	5 5½	5 8	5 10	6 0½	6 3	6 5½	6 8	6 10½
Corr. for every 10 feet of Length, - -	IN. 1·2	IN. 1·2	IN. 1·3	IN. 1·3	IN. 1·3	IN. 1·3	IN. 1·3	IN. 1·4	IN. 1·4	IN. 1·4	IN. 1·4	IN. 1·4
Deduction for Summer Voyages, - - -	3·0	3·0	3·0	3·0	3·0	3·5	3·5	3·5	3·5	4·0	4·0	4·0

Add 2 inches for Winter North Atlantic Freeboard.

Table B.

RELATING TO CARGO-CARRYING SPAR-DECKED VESSELS.

(Section Reproduced for Working the Examples).

Freeboard Measured from Top of Spar Deck at Side.

Length (in feet), - -	390	396	402	408	414	420	426	432	438	444
Moulded Depth, - -	FT. IN. 25 6	FT. IN. 26 0	FT. IN. 26 6	FT. IN. 27 0	FT. IN. 27 6	FT. IN. 28 0	FT. IN. 28 6	FT. IN. 29 0	FT. IN. 29 6	FT. IN. 30 0
	Winter Freeboard (in feet and inches).									
	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.
Coeff. of Fineness, ·68	9 0	9 2½	9 5½	9 8	9 11	10 2	10 5	10 8½	10 11½	11 3
,, ,, ·70	9 1½	9 3½	9 6½	9 9	10 0	10 3	10 6	10 9½	11 0½	11 4
,, ,, ·72	9 2	9 4½	9 7½	9 10	10 1	10 4	10 7	10 10½	11 1½	11 5
,, ,, ·74	9 3	9 5½	9 8½	9 11	10 2	10 5	10 8	10 11½	11 2½	11 6
,, ,, ·76	9 3½	9 6	9 9	10 0	10 3	10 6	10 9	11 0½	11 3½	11 7
,, ,, ·78	9 4½	9 7	9 10	10 1	10 4	10 7	10 10	11 1½	11 4½	11 8
,, ,, ·80	9 5	9 7½	9 10½	10 1½	10 4½	10 7½	10 10½	11 2	11 5½	11 9
,, ,, ·82	9 6	9 8½	9 11½	10 2½	10 5½	10 8½	10 11½	11 3	11 6½	11 10
Corr. for every 10 feet of Length, - -	INS. 1·3	INS. 1·3	INS. 1·4	INS. 1·4	INS. 1·4	INS. 1·4	INS. 1·5	INS. 1.5	INS. 1·5	INS. 1·5
Deduction for Summer Voyages, - - -	INS. 5½	INS. 5½	INS. 5½	INS. 6	INS. 6	INS. 6	INS. 6	INS. 6½	INS. 6½	INS. 6½

These Tables apply to spar-decked vessels with height between main and spar deck of 7 feet (measured from beam top to beam top). A greater height requires adjustment.

Table C.

RELATING TO CARGO-CARRYING AWNING-DECKED VESSELS.

(SECTION REPRODUCED FOR WORKING EXAMPLES).

FREEBOARD MEASURED FROM TOP OF MAIN DECK.

Length (in feet), - -	276	282	288	294	300	306	312	318	324	330	336	342
Moulded Depth (to Main-deck), - - -	FT. IN. 23 0	FT. IN. 23 6	FT. IN. 24 0	FT. IN. 24 6	FT. IN. 25 0	FT. IN. 25 6	FT. IN. 26 0	FT. IN. 26 6	FT. IN. 27 0	FT. IN. 27 6	FT. IN. 28 0	FT. IN. 28 6
	WINTER FREEBOARD.											
	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.
Coeff. of Fineness, ·68	1 10½	2 0	2 1½	2 3½	2 5	2 7	2 8½	2 10½	3 1	3 3	3 5	3 7
,, ,, ·70	1 11	2 0½	2 2	2 4	2 5½	2 7½	2 9	2 11	3 1½	3 3½	3 5½	3 7½
,, ,, ·72	1 11½	2 1	2 2½	2 4½	2 6	2 8	2 9½	2 11½	3 2	3 4	3 6	3 8
,, ,, ·74	1 11½	2 1	2 3	2 5	2 6½	2 8½	2 10	3 0	3 2½	3 4½	3 6½	3 8½
,, ,, ·76	2 0	2 1½	2 3½	2 5½	2 7	2 9	2 11	3 1	3 3½	3 5½	3 7½	3 9½
,, ,, ·78	2 0½	2 2	2 4	2 6	2 7½	2 9½	2 11½	3 1½	3 4	3 6	3 8	3 10
,, ,, ·80	2 1	2 2½	2 4½	2 6½	2 8	2 10	3 0	3 2	3 4½	3 6½	3 8½	3 10½
Corr. for change of 10 feet in the Length, -	IN. ·6	IN. ·6	IN. ·6	IN. ·7	IN. ·7	IN. ·7	IN. ·7	IN. ·7	IN. ·7	IN. ·7	IN. ·7	IN. ·7
Deduction for Summer Voyages, - - -	IN. 4	IN. 4½	IN. 4½	IN. 4½	IN. 5	IN. 5	IN. 5	IN. 5½	IN. 5½	IN. 5½	IN. 5½	IN. 6

Add 2 inches for Winter North Atlantic for vessels under 330 feet.

Table D.

RELATING TO SEA-GOING IRON OR STEEL SAILING VESSELS.

(SECTION REPRODUCED FOR WORKING THE EXAMPLES).

FREEBOARD MEASURED FROM TOP OF DECK AT SIDE.

Percentage of Reserve Buoyancy, - -	29·8	30·0	30·2	30·4	30·6	30·8	31·1	31·4
Length, - - -	FT. 275	FT. 280	FT. 285	FT. 290	FT. 295	FT. 300	FT. 305	FT. 310
Moulded Depth, - -	FT. IN. 27 6	FT. IN. 28 0	FT. IN. 28 6	FT. IN. 29 0	FT. IN. 29 6	FT. IN. 30 0	FT. IN. 30 6	FT. IN. 31 0
	SUMMER FREEBOARD.							
	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.
Coeff. of Fineness, ·66	5 11½	6 1½	6 3	6 5	6 7	6 9	6 11	7 1
,, ,, ·68	6 0½	6 2	6 4	6 6	6 8	6 10	7 0	7 2
,, ,, ·70	6 1	6 3	6 5	6 7	6 9	6 11	7 1	7 3
,, ,, ·72	6 2	6 4	6 5½	6 7½	6 9½	6 11½	7 1½	7 3½
,, ,, ·74	6 2½	6 4½	6 6	6 8	6 10	7 0	7 2	7 4
,, ,, ·76	6 3½	6 5½	6 7	6 9	6 11	7 1	7 3	7 5
Corr. for change of 10 feet in the Length, -	INS. 1·4	INS. 1·4	INS. 1·4	INS. 1·4	INS. 1·4	INS. 1·5	INS. 1·5	INS. 1·5

Add 3 inches for Winter North Atlantic.

TABLE of Mean Sheer relating to Flush-Deck Vessels and Vessels with Erections on Deck, such as Poops, Forecastles, Bridge House, etc. No Notice is taken of Sheer in Spar or Awning Deckers.

Length over which Sheer is Measured, - -	100	150	200	250	300	350	400	Points of Measurement.
	Mean Sheer over Length specified.							
	IN.	IN.	IN.	IN.	IN.	IN.	IN.	
Flush-deck vessels, -	20	25	30	35	40	45	50	Abreast the stem and sternpost.
Vessels having short poops and forecastles,	14	18	22	26	30	34	38	At ⅛ the length of the vessel from each end.
Vessels having short forecastles only,	14½	18½	23	27	31	35½	40	Abreast the sternpost, and at ⅛ the length of the vessel from the stem.

TABLE Showing Increased Submersion or Reduction in Freeboard when Loading in Fresh Water.

Moulded Depth.	Reduction in Freeboard.		
	Flush Decker.	Awning Decker.	Spar Decker.
9 ft. and under 11 ft.	2 inches.	—	—
11 ,, ,, 13 ,,	2½ ,,	—	—
13 ,, ,, 16 ,,	3 ,,	3½ inches.	4 inches.
16 ,, ,, 19 ,,	3½ ,,	4 ,,	4½ ,,
19 ,, ,, 22 ,,	4 ,,	4½ ,,	5 ,,
22 ,, ,, 25 ,,	4½ ,,	5 ,,	5½ ,,
25 ,, ,, 28 ,,	5 ,,	5½ ,,	6 ,,
28 ,, ,, 31 ,,	5½ ,,	6 ,,	6½ ,,
31 ,, ,, 34 ,,	6 ,,	6½ ,,	7 ,,

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